CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ PROTOCOL
CNPS VEGETATION COMMITTEE
October 20, 2000 (Revised 8/23/2007)

Introduction

In *A Manual of California Vegetation* (Sawyer and Keeler-Wolf 1995), CNPS published a
Vegetation Sampling Protocol that was developed as a simple quantitative sampling technique
applicable to many vegetation types in California. Investigators use an ocular estimation
technique called a relevé to classify and map large areas in a limited amount of time.

The relevé method of sampling vegetation was developed in Europe and was largely
standardized by the Swiss ecologist Josias Braun-Blanquet. He helped classify much of
Europe's vegetation, founded and directed a synecology center in France, and was editor of
Vegetatio for many years. The relevé was, and is, a method used by many European ecologists,
and others around the world. These ecologists refer to themselves as phytosociologists. The use
of relevé in the United States has not been extensive with the exception of the US Forest Service.

The relevé is particularly useful when observers are trying to quickly classify the range of
diversity of plant cover over large units of land. In general, it is faster than the point intercept
technique. One would use this method when developing a classification that could be used to
map of a large area of vegetation, for example. This method may also be more useful than the
line intercept method when one is trying to validate the accuracy of mapping efforts.

The relevé is generally considered a "semiquantitative" method. It relies on ocular estimates of
plant cover rather than on counts of the "hits" of a particular species along a transect line or on
precise measurements of cover/biomass by planimetric or weighing techniques.

Selecting a stand to sample:

A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some
vegetation stands are very small, such as alpine meadow or tundra types, and some may be
several square kilometers in size, such as desert or forest types. A stand is defined by two main
unifying characteristics:

  1) It has <u>compositional</u> integrity. Throughout the site the combination of species is similar.
     The stand is differentiated from adjacent stands by a discernable boundary that may be
     abrupt or indistinct, and
  2) It has <u>structural</u> integrity. It has a similar history or environmental setting that affords
     relatively similar horizontal and vertical spacing of plant species throughout.
     For example, a hillside forest originally dominated by the same species that burned on the
     upper part of the slopes, but not the lower, would be divided into two stands. Likewise, a
     sparse woodland occupying a slope with very shallow rocky soils would be considered a
     different stand from an adjacent slope with deeper, moister soil and a denser woodland or
     forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand it must be homogeneous.

Stands to be sampled may be selected by assessment prior to a site visit (e.g. delineated from aerial photos or satellite images), or may be selected on site (during reconnaissance to determine extent and boundaries, location of other similar stands, etc.). Depending on the project goals, you may want to select just one or a few representative stands for sampling (e.g., for developing a classification for a vegetation mapping project), or you may want to sample all of them (e.g., to define a rare vegetation type and/or compare site quality between the few remaining stands).

Selecting a plot to sample within in a stand:

Because most stands are large, it is difficult to summarize the species composition, cover, and structure of an entire stand.   We are also usually trying to capture the most information with the least amount of effort. Thus, we are typically forced to select a representative portion to sample.

When sampling a vegetation stand, the main point to remember is to select a sample that, in as many ways possible, is representative of that stand. This means that you are not randomly selecting a plot; on the contrary, you are actively using your own best judgement to find a representative example of the stand.

Selecting a plot requires that you see enough of the stand you are sampling to feel comfortable in choosing a representative plot location. Take a brief walk through the stand and look for variations in species composition and in stand structure. In many cases in hilly or mountainous terrain look for a vantage point from which you can get a representative view of the whole stand. Variations in vegetation that are repeated throughout the stand should be included in your plot. Once you assess the variation within the stand, attempt to find an area that captures the stand's common species composition and structural condition to sample.

Plot Size

All releves of the same type of vegetation to be analyzed in a study need to be the same size. It wouldn't be fair, for example, to compare a 100 m2 plot with a 1000 m2 plot as the difference in number of species may be due to the size of the plot, not a difference in the stands.

A minimal area to sample is defined by species/area relationships; as the sampler identifies species present in an area of homogeneous vegetation, the number will increase quickly as more area is surveyed. Plot shape and size are somewhat dependent on the type of vegetation under study. Therefore general guidelines for plot sizes of tree-, shrub-, and herb-dominated upland, and fine-scale herbaceous communities have been established. Sufficient work has been done in temperate vegetation to be confident the following conventions will capture species richness:

> Alpine meadow and montane wet meadow: 100 sq. m
> Herbaceous communities: 10 sq. m plot, 100 sq. m plot or 400 sq. m plot (Consult with
>   CNPS, and use one consistent size)
> Shrublands: 400 sq. m plot
> Forest and woodland communities: 1000 sq. m plot
> Open desert vegetation: 1000 sq. m plot

Plot Shape

A relevé has no fixed shape, plot shape should reflect the character of the stand. If the stand is about the same size as a relevé, you need to sample the entire stand.   If we are sampling a desert wash, streamside riparian, or other linear community our plot dimensions should not go beyond the community's natural ecological boundaries. Thus, a relatively long, narrow plot capturing the vegetation within the stand, but not outside it would be appropriate. Species present along the edges of the plot that are clearly part of the adjacent stand should be excluded.

If we are sampling broad homogeneous stands, we would most likely choose a shape such as a circle (which has the advantage of the edges being equidistant to the center point) or a square (which can be quickly laid out using perpendicular tapes). If we are trying to capture a minor bit of variety in the understory of a forest, for example a bracken fern patch within a ponderosa pine stand, we would want both bracken and non-bracken understory. Thus, a rectangular shape would be appropriate.

GENERAL PLOT INFORMATION

The following items appear on each data sheet and are to be collected for all plots. Where indicated, refer to attached code sheet.

Polygon or Relevé number: Assigned either in the field or in the office prior to sampling.

Date: Date of sampling.

County: County in which located.

USGS Quad: The name of the USGS map the relevé is located on; note series (15' or 7.5').

CNPS Chapter: CNPS chapter, or other organization or agency if source is other than CNPS chapter.

Landowner: Name of landowner or agency acronym if known. Otherwise, list as private.

Contact Person: Name, address, and phone number of individual responsible for data collection.

Observers: Names of individuals assisting. Circle name of recorder.

Plot shape: indicate the sample shape as: square, rectangle, circle, or the entire stand.

Plot size: length of rectangle edges, circle radius, or size of entire stand. NOTE: See page 2 for standard plot sizes.

Study Plot Revisit: If the relevé plot is being revisited for repeated sampling, please circle "Yes".

Photo interpreter community code: If the sample is in area for which delineation and photo interpretation has already been done, the code which the photointerpreters applied to the polygon. If the sample site has not been photointerpreted, leave blank.

Other polygons of same type (yes or no, if applicable), if yes, mark on map: Other areas within view that appear to have similar vegetation composition. Again, this is most relevant to areas that have been delineated as polygons on aerial photographs as part of a vegetation-mapping project. If one is not working from aerial photographs, draw the areas as on a topographic map.

Is plot representative of whole polygon? (yes or no, if applicable), if no explain: Detail what other vegetation types occur in the polygon, and what the dominant vegetation type is if there is more than one type.

Global Positioning System Readings: Due to the recent availability of very accurate and relatively low cost GPS units, we highly recommend obtaining and using these as a standard piece of sampling equipment. Now that the military intentional imprecision (known as "selective availability") has been "turned off" (as of July 2000), it is typical for all commercial GPS units these units to be accurate to within 5 m of the actual location. Also note that the GPS units can be set to read in UTM or Latitude and Longitude coordinates and can be easily translated. Thus, the following fields for Latitude, Longitude, and legal description are now optional. In order for all positional data to be comparable within the CNPS vegetation dataset, we request using UTM coordinates set for the NAD 83 projection (see your GPS users manual for instructions for setting coordinates and projections).

Caveat: Although GPS units are valuable tools, they may not function properly due to the occasionally poor alignment of satellites or due to the complexity of certain types of terrain, or vegetation. We thus also recommend that you carry topographic maps and are aware of how to note your position on them in the event of a non-responsive or inaccurate GPS.

UTMN and UTME: Northing and easting coordinates using the Universal Transverse Mercator (UTM) grid as delineated on the USGS topographic map, or using a Global Positioning System.

UTM zone: Universal Transverse Mercator zone. Zone 10S for California west of the 120th longitude; zone 11S for California east of 120th longitude.

Legal Description: Township/Range/Section/Quarter Section/Quarter-Quarter section/Meridian: Legal map location of the site; this is useful for determining ownership of the property. California Meridians are Humboldt, Mt. Diablo, or San Bernardino. (This is optional, see above discussion of GPS units)

Latitude and Longitude: Degrees north latitude and east longitude. This is optional (see above)

Elevation: Recorded in feet or meters. Please indicate units.

Slope: Degrees, read from clinometer or compass, or estimated; averaged over relevé

Aspect: Degrees from true north (adjust declination), read from a compass or estimated; averaged over relevé.

Macrotopography: Characterize the large-scale topographic position of the relevé. This is the general position of the sample along major topographic features of the area. *See attached code list.*

Microtopography: Characterize the local relief of the relevé. Choose the shape that mimics the lay of the ground along minor topographic features of the area actually within the sample. *See attached code list.*

VEGETATION DESCRIPTION

Dominant layer: Indicate whether the community is dominated by the Low layer (L), Mid-layer (M), or Tall (T) layer.

Preliminary Alliance name: Name of series, stand, or habitat according to CNPS classification (per Sawyer and Keeler-Wolf 1995); if the type is not defined by the CNPS classification, note this in the space.

Dominant Vegetation Group: Use code list to choose group

Phenology: Based on the vegetative condition of he principal species, characterize the phenology of each layer as early (E), peak (P), or late (L).

WETLAND COMMUNITY TYPES

Community type: Indicate if the sample is in a wetland or an upland; note that a site need not be officially delineated as a wetland to qualify as such in this context.

Dominant vegetation form: This is a four letter code which relates the vegetation of the plot to the higher levels of the NBS/NPS National Vegetation Classification System hierarchy. *See attached code list.*

Cowardin class: See "Artificial Keys to Cowardin Systems and Names" (attached). If the plot is located in a wetland, record the proper Cowardin system name. Systems are described in detail in Cowardin et al. 1979. Classification of wetlands and deepwater habitats of the United States. US Dept. of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

Marine: habitats exposed to the waves and currents of the open ocean (subtidal and intertidal habitats).

Estuarine: includes deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land (i.e. estuaries and lagoons).

Riverine: includes all wetlands and deepwater habitats contained within a channel, excluding any wetland dominated by trees, shrubs, persistent emergent plants, emergent mosses, or lichens. Channels that contain oceanic-derived salts greater than 0.5% are also excluded.

Lacustrine: Includes wetlands and deepwater habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees or shrubs, persistent emergents, emergent mosses or lichens with greater than 30% aerial coverage; and total area exceeds 8 ha (20 acres). Similar areas less than 8 ha are included in the lacustrine system if an active wave-formed or bedrock shoreline feature makes up all or part of the low tide boundary, of if the water in the deepest part of the basin exceeds 2 m (6.6 feet) at low tide. Oceanic derived salinity is always less than 0.5%.

Palustrine: Includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity derived from oceanic salts is less than 0.5%. Also included are areas lacking vegetation, but with all of the following four characteristics: 1) areas less than 8 ha (20 acres); active wave-formed or bedrock shoreline features lacking; 3) water depth in the deepest part of the basin less than 2 m (6.6 feet) at low water; and 4) salinity due to ocean-derived salts less than 0.5%.

Vertical distance from high water mark of active stream channel: If the plot is in or near a wetland community, record to the nearest meter or foot the estimated vertical distance from the middle of the plot to the average water line of the channel, basin, or other body of water.

Horizontal distance from high water mark of active stream channel: If the plot is in or near a wetland community, record to the nearest meter or foot the estimated horizontal distance from the middle of the plot to the average water line of the channel, basin, or other body of water.

Stream channel form: If the plot is located in or near a community along a stream, river, or dry wash, record the channel form of the waterway. The channel form is considered S (single channeled) if it consists of predominately a single primary channel, M (meandering) if it is a meandering channel, and B (braided) if it consists of multiple channels interwoven or braided.

Adjacent alliance: Adjacent vegetation series, stands or habitats according to CNPS classification; list in order of most extensive to least extensive. Give the name of the alliance, the direction in relation to stand and list up to four species under Description.

Photographs: Write the name or initials of the camera owner and the JPEG numbers for photos taken. Write the camera's view direction from compass bearings. Take four or eight photos (depending on the project) from the same point as the GPS reading (center of a circle or NW corner of rectangle). Using a compass, take the first photo from the north, and rotate clockwise, taking the photos in sequence, N, NE, E etc, or N, E, S, W. Keep camera at same orientation, zoom level, and distance from ground for all four (or eight) photos., You may take photos close to the ground, if for instance, you are photographing a low herbaceous stand. Additional photos of the stand may also be helpful. If using a digital camera or scanning in the image into a computer, relevé numbers and compass directions can be recorded digitally. If using a 35mm camera, please note the roll number, frame number, compass direction, and the initials of the person whose camera is being used. (e.g. Roll 5, #1, to the NW, SE)

STAND AND ENVIRONMENTAL INFORMATION

<u>Vegetation trend</u>: Based on the regenerating species and relationship to surrounding vegetation, characterize the stand as either increasing (expanding), stable, decreasing, fluctuating, or unknown.

<u>Impacts</u>: Enter codes for potential or existing impacts on the stability of the plant community. Characterize each as either 1. Light, 2. Moderate, of 3. Heavy. *See attached code list.*

<u>Site location and plot description</u>: A concise, but careful description that makes locating and/or revisiting the vegetation stand and plots possible; give landmarks and directions. Used in conjunction with the GPS position recorded earlier, this should enable precise re-location of the plot. Indicate where the GPS reading was taken within the plot. In general, the location of the GPS reading should be on the Northwestern corner of the plot, if the plot is rectangular (or square), or in the center if the plot is circular. It is also helpful to briefly describe the topography, aspect, and vegetation structure of the site. If you can't take the GPS reading at the Northwest corner (an obstacle in the way) then note where the GPS point was taken. If you can't get a GPS reading, then spend extra time marking the plot location as precise as possible on a topo map.

<u>Site history</u>: Briefly describe the history of the stand, including type and year of disturbance (e.g. fire, landslides or avalanching, drought, flood, or pest outbreak). Also note the nature and extent of land use such as grazing, timber harvest, or mining.

<u>Unknown plant specimens</u>: List the numbers of any unknown plant specimens, noting any information such as family or genus (if known), important characters, and whether or not there is adequate material for identification. Do not take samples of plants of which there are only a few individuals or which you think may be rare. Document these plants with photographs.

<u>Additional comments</u>: Feel free to note any additional observations of the site, or deviations from the standard sampling protocol. If additional data were recorded, e.g. if tree diameters were measured, please indicate so here.

SURFACE COVER AND SOIL INFORMATION

<u>Surface cover</u>: Estimate the cover class of each size at or near the ground surface averaged over the plot. Always remember to estimate what you actually see on the surface as opposed to what you think is hiding under, organic litter, big rocks, etc. However, rocks, organic litter, or fine material visible under the canopy of shrubs or trees should be included in the cover estimate.

One way to consider this is to assume that all of the components of surface cover plus the basal cross-section of living plant stems and trunks (at ground level) will add up to 100%. Thus, estimate the cover value of each of the items in the box on the form for surface cover (including the basal area of plant stems) so that they will add up to 100%. Remember that the basal area of plant stems is usually minimal (e.g., if there were 10 trees, each 1 m in diameter at ground level on a 1000 square meter plot, they would cover less than 1% {0.79%} of the plot).

These data are asked for because certain categories of surface cover of rock and other materials have been shown to correlate with certain vegetation types and are thus likely influencing the type of vegetation that is growing in a given area. These estimates should be made quickly with the main point to keep in mind being a rough estimate of the relative proportions of different coarse fragments on the plot.

Fines: Fine mineral fragments including sand, silt, soil, "dirt" < 2 mm in diameter

Gravel: rounded and angular fragments 0.2-7.5 cm (0.08 -3 in.) diameter

Cobble: rounded and angular fragments >7.5-25 cm (3 -10 in.) in diameter

Stone: rounded and angular coarse fragments >25 cm-60 cm (10 -24 in.) in diameter

Boulder: rounded and angular coarse fragments >60 cm (>24 in.) in diameter

Bedrock: continuous, exposed, non-transported rock

Litter: extent of undecomposed litter on surface of plot (this includes all organic matter, e.g. fallen logs, branches, and twigs down to needles and leaves).

Living stems of vascular plants: basal area of living stems of the plants at ground surface

<u>% Bioturbation</u>: Estimate percent cover of ground disturbance by animals (e.g., small mammal burrowing trails, cow hoof marks) across the entire plot surface.

<u>Soil texture</u>: Record the texture of the upper soil horizon, below the organic layer if one is present. *See attached key and code list*.

<u>Parent Material</u>: Geological parent material of site. *See attached code list*.

VEGETATION DATA

Assessment of Layers
Data are recorded for five layers (tree overstory, tree understory, shrub, herb, and non-vascular). The layer a species occupies is determined by life-form. The estimates need not be overly precise and will vary among vegetation types. A young tree, if shrub sized, is considered an understory tree. A caveat: if several relevés are being sampled within the same vegetation type, it is important to be consistent when assigning layers. Some types will have more than five layers (e.g. two tree layers of different maximum height); this should be indicated in the relevé description.

Species List

The collection of vegetation data continues with making a comprehensive species list of all vascular plants within the relevé. This list is achieved by meandering through the plot to see all

microhabitats. During list development, observers document each taxon present in each layer in which it occurs separately, recording it on a different line of the data form and noting which layer is represented. This is important for data entry because each layer of each represented taxon will be entered separately. Each individual plant is recorded in only one layer, the layer in which the tallest portion of the individual is found. One should reach a point at which new taxa are added to the list only very slowly, or sporadically. When one has reached that point, the list is probably done.

The following sections explain how to perform the actual relevé, the Estimation of Cover Values. The sections prefaced by bold-faced titles explain the technique, and the sections with regular font titles refer to the steps needed to complete the accompanying Field Form.

DBH – see separate field form (optional)

DBH if >10 cm:

The diameter at breast height (dbh) is important in certain studies. It may be recorded next to each tree species name. First indicate the species name by code and then record the number of sprouts/trunks in clonal trees. You should measure the tree dbh of every tree trunk/sprout that has diameter > or = 10 cm at breast height in the plot, and each measurement should be in centimeters (cm) using a dbh tape measure. For trunks that may be fused below breast height and branched at breast height, each trunk at breast height gets a separate measurement.

Also indicate if each tree/clone is in the overstory or understory. Trees in the overstory are generally at canopy level. Trees in the understory are entirely below the general level of the canopy.

If snags are encountered in plot, record the dbh and denote it as dead by circling its dbh measurement. If you are unable to identify the snag to species, put the four letter code "SNAG" in the species column.

Depending on the density of trees in each plot, you can record dbh of trees for every tree trunk in the plot, or you can sub-sample the trunks to estimate dbh for every tree species in relatively dense plots. For woodland/forest plots, sub-sampling is appropriate for half the plot if there are at least 50 trees/resprouts present (e.g., 200 m^2 sub-sample in riparian and 500 m^2 sub-sample in upland).

When sub-sampling, make sure to denote this as a sub-sample (note on the data form) and record the sub-sample of dbh's for each tree species in the appropriate row on the Field Form. Once the data are post-processed and entered into a database, then you will need to record each sub-sampled dbh reading three additional times to come up with a full sample of dbh readings. For example, with a sub-sampled tree dbh of 15 cm, this value of 15 should be entered four times (not just once) when it is entered in the database.

Lifeform and size class: If dbh <15.2 cm, counts should be made for conifers and hardwoods in two different size classes. Count seedlings ($\leq$ 2.54 cm) and saplings (> 2.54 but < 15.2 cm). First estimate if there are more than 50 seedlings in one half (50% subsample) of the plot. If so, then do counts of seedlings and saplings in five sub-plots of 2x2 m squares. If the plot shape is a

circle, place one square in the center of the plot, and four other squares 10 m to the N, S, E, and W of the plot center. If there are less than 50 seedlings in the 50% subsample plot, then record counts for that subsample instead.

Estimating Cover:

There are many ways to estimate cover. Many people who have been in the cover estimation "business" for a long time can do so quickly and confidently without any props and devices. However, to a novice, it may seem incomprehensible and foolhardy to stand in a meadow of 50 different species of plants and systematically be able to list by cover value each one without actually "measuring" them in some way.

Of course, our minds make thousands of estimates of various types every week. We trust that estimating plant cover can be done by anyone with an open mind and an "eye for nature." It's just another technique to learn.

It is very helpful to work initially with other people who know and are learning the technique. In such a group setting, typically a set of justifications for each person's estimate is made and a "meeting of the minds" is reached. This consensus approach and the concomitant calibration of each person's internal scales is a very important part of the training for any cover estimate project.

An underlying point to remember is that estimates must provide some level of reliable values that are within <u>acceptable</u> bounds of accuracy. If we require an accuracy level that is beyond the realm of possibility, we will soon reject the method for one more quantitative and repeatable. As with any scientific measurement, the requirement for accuracy in the vegetation data is closely related to the accuracy of the information needed to provide a useful summary of it. Put into more immediate perspective - **to allow useful and repeatable analysis of vegetation data, one does not need to estimate down to the exact percent value the cover of a given plant species in a given stand**.

This point relates to two facts: there is inherent variability of species cover in any environment. For example, you would not expect to always have 23% *Pinus ponderosa*, 14% *Calocedrus decurrens,* and 11% *Pinus lambertiana* over an understory of 40% *Chamaebatia foliosa*, 3% *Clarkia unguiculata*, and 5% *Galium bolanderi* to define the Ponderosa pine-Incense cedar/mountain misery/bolander bedstraw plant community.   Anyone who has looked at plant composition with a discerning eye can see that plants don't space themselves in an environment by such precise rules. Thus, we can safely estimate the representation of species in a stand by relatively broad <u>cover classes</u> (such as <1%, 1-5 %, 5-25%, etc.) rather than precise percentages.

The data analysis we commonly use to classify vegetation into different associations and series (TWINSPAN and various cluster analysis programs, for example) is likewise forgiving. When analyzed by quantitative mutivariate statistics information on species cover responds to coarse differences in cover and presence and absence of species, but not to subtle percentage point differences. This has been proven time and again through quantitative analysis of vegetation classification.   Many of the world's plant ecologists estimate cover rather than measure it precisely. Some of the seminal works in vegetation ecology have been based on cover estimates taken by discerning eyes.

With this as a preamble, below we offer some suggestions on estimating cover that have proven helpful. These are simply "tricks" to facilitate estimation, some work better for different situations. You may come up with other methods of estimation that may seem more intuitive, and are equally reliable in certain settings. All values on the relevé protocol that require a cover class estimate, including coarse fragment and vegetation layer information, may rely on these techniques. Just make the appropriate substitutions (using the coarse fragment example substitute, bedrock, stone, cobbles, gravel, and litter for vegetation).

Method 1: The invisible point-intercept transect:

This method works well in relatively low, open vegetation types such as grasslands and scrubs where you can see over the major stand components. For those who have worked with the original CNPS line intercept methodology it's like counting hits along an imaginary line at regular intervals of the 50 m tape. Here's how it goes:

Envision an imaginary transect line starting from your vantage point and running for 50 m (or however many meters you wish, as long as you are still ending up within the same stand of vegetation you're sampling - never keep counting outside of your homogeneous stand). Now "walk" your eye along this tape for 50 m and visually "take a point" every 0.5 m. Don't worry about precision, just try to "walk" your eye along the line and stop every 0.5 m or at any other regular interval until you reach its end and mentally tally what species you hit. Once you come up with a number of hits for each major species in one imaginary transect, take another transect in another direction and estimate the number of hits on that one. Do this several times (usually 3-4 is enough if you are in a homogeneous stand), then average your results.

This can go quickly in simple environments and in environments where the major species are easily discernable (chaparral, bunch-grassland, coastal scrub, desert scrub). Your average number of hits need not be a total of 100 as in the original transect method, but could be 50 along a 25 m imaginary line (in which case you would multiply by two to get your estimated cover), or 25 along a 12.5 m line (multiply average by 4), etc.

Method 2: Subdivision of sample plot into quadrants:

Many plots, whether they are square, circular, or rectangular, may be "quartered" and have each quadrant's plant cover estimated separately. If the plot is a given even number of square meters (such as 100, 400, or 1000 m^2) then you know that a quarter of that amount is also an easily measurable number. If you can estimate the average size of the plants in each of the quarters (e.g, small pinyon pines may be 5 m^2 (2.2m x 2.2m), creosote bush may be 2m^2 (or 1.41 m x 1.41 m), burrobush may be 0.5m^2) then you simply count the number of plants in each size class and multiply by their estimated size for the cover in a given quadrant. Then you average the 4 quadrants together for your average cover value.

This method works well in vegetation with open-to-dense cover of low species such as grasses or low shrubs, in open woodlands, and desert scrubs.

Method 3; "Squash" all plants into a continuous cover in one corner of the plot:

Another way to estimate how much of the plot is covered by a particular species is to mentally group (or "march", or "squash") all members of that species into a corner of the plot and estimate the area they cover. Then calculate that area as a percentage of the total plot area. This technique works well in herb and shrub dominated plots but is not very useful in areas with trees.

Method 4: How to estimate tree cover:

Cover estimates of tall trees is one of the most difficult tasks for a beginning relevé sampler. However it is possible to do this with consistency and reliability using the following guidelines.

1.   Have regular sized and shaped plots that you can easily subdivide.
2.   Estimate average crown spread of each tree species separately by pacing the crown diameter of representative examples of trees of each species and then roughly calculating the crown area of each representative species.
3.   Add together the estimated crown area of each individual of each species of tree on the plot for your total cover.

Method 5: The process of elimination technique:

This method is generally good for estimating cover on sparsely vegetated areas where bare ground, rocks, or cobbles cover more area than vegetation. In such a situation it would be advisable to first estimate how much of the ground is not covered by plants and then subdivide the portion that is covered by plants into rough percentages proportional to the different plant species present. For example, in a desert scrub the total plot not covered by plants may be estimated at 80%. Of the 20% covered by plants, half is desert sunflower (10% cover), a quarter is California buckwheat (5% cover), an eighth brittlebush (2.5% cover), and the rest divided up between 10 species of herbs and small shrubs (all less than 1% cover).

Any of these techniques may be used in combination with one another for a system of checks and balances, or in stands that have characteristics lending themselves for a different technique for each layer of vegetation.

In a relevé, cover estimates, using the techniques described above, are made for each taxon as it is recorded on the species list. Estimates are made for each layer in which the taxon was recorded. For example, if individuals of coast live oak occur in the tree overstory (canopy trees) and tree understory (seedlings and saplings), an estimate is made for both layers should be recorded.

In a traditional relevé, cover is estimated in "cover classes," not percentages, because of the variability of plant populations over time and from one point to another, even within a small stand. This protocol uses the following 6 cover classes:

Cover Class 1: the taxon in that layer covers < 1 % of the plot area
Cover Class 2: the taxon in that layer covers 1 % - 5 % of the plot area
Cover Class 3a: the taxon in that layer covers >5 - 15 % of the plot area

Cover Class 3b: the taxon in that layer covers >15 - 25 % of the plot area
Cover Class 4: the taxon in that layer covers >25 - 50 % of the plot area
Cover Class 5: the taxon in that layer covers >50 - 75 % of the plot area
Cover Class 6: the taxon in that layer covers > 75% of the plot area

Percentages (optional)

This CNPS protocol also encourages observers to estimate percentages if they feel confident in their estimation abilities. This optional step allows the data to be compared more easily to data collected using different methods, such as a line or point intercept. It also instills confidence in the cover estimate of borderline species that are close calls between two cover classes (e.g., a cover class 2 at 5% as opposed to a cover class 3 at 6%). It is particularly useful for calculating cover by the process of elimination techniques and for estimating total vegetation cover (see below) and coarse fragment cover.

Overall Cover of Vegetation

In addition to cover of individual taxa described above, total cover is also estimated for each vegetation layer. This is done using the same cover classes as described above but combines all taxa of a given category. They can be calculated from the species percent cover estimates, but please make sure to disregard overlap of species within each layer. These estimates should be absolute aerial cover, or the "bird's eye view" of the vegetation cover, in which each category cannot be over 100%.

To come up with a specific number estimate for percent cover, first use to the cover intervals, used in the species cover estimates, as a reference aid to get a generalized cover estimate: While keeping these intervals in mind, you can then refine your estimate to a specific percentage for each category below.

% Overstory Conifer/Hardwood Tree: The total aerial cover (canopy closure) of all live tree species that are specifically in the overstory or are emerging, disregarding overlap of individual trees. Estimate conifer and hardwood covers separately. Please note: These cover values should not include the coverage of suppressed understory trees.

%Low-Medium Tree: The total aerial cover (canopy closure) of all live understory low to medium height tree species, disregarding overlap of individual trees and shrubs. This category contains recruits of overstory tree species (with seedlings and saplings in the understory) and understory tree species that typically do not make up the overstory canopy (e.g. trees that typically do not attain a height >10m).

% Shrub: The total aerial cover (canopy closure) of all live shrub species disregarding overlap of individual shrubs.

% Herb: The total aerial cover (canopy closure) of all herbaceous species, disregarding overlap of individual herbs.

% Total Vascular plants: The total aerial cover of all vegetation. This is an estimate of the absolute vegetation cover, disregarding overlap of the various tree, shrub, and/or herb layers.

% Total Non-vascular plants: The total cover of all lichens and bryophytes (mosses, liverworts, hornworts) on substrate surfaces (not standing or inclined trees).

<u>Modal height for conifer/hardwood tree, shrub, and herbaceous categories (optional)</u>
If height values are important in your vegetation survey project, provide an ocular estimate of height for each category listed. Record an average height value per each category by estimating the mean height for each group. Please use the following height intervals to record a height class: 01=<1/2m, 02=1/2-1m, 03=1-2m, 04=2-5m, 05=5-10m, 06=10-15m, 07=15-20m, 08=20-35m, 09=35-50m, 10=>50m.

Caveats
Please consult with the members of the vegetation committee for advice and feedback on proposed vegetation surveys prior on initiating projects.

<u>Notes on the Order and Division of Labor for Data Collection</u>:   As with every procedure, there are always more and less efficient ways to collect the information requested. Although we respect each field crews' option to choose in what order they collect the data, we suggest the following general rules:

- Work with teams of two for each plot collected.
- Both team members can determine the plot shape and size and lay out the tapes and mark the edges for the plot boundary (see below).
- The two person teams can also divide up tasks of data collection with one member collecting location, environmental (slope, aspect, geology, soil texture, etc.) and plot description information while the other begins the species list. Thus, two clipboards are useful and data sheets that are at first separated (not stapled).
- Following the making of the initial species list and collection of location and environmental data both team members convene to do the estimation of plant cover by species followed by the estimation of total vegetation cover and cover by layer.
- Following that process, the estimation of cover by the up to 10 height strata classes and the listing of the diagnostic species for each is done collaboratively.
- This is followed by the estimation of the coarse fragment information, again done collaboratively.

For egalitarian and familiarization purposes we suggest that the roles be switched regularly between the team members and that if multiple teams are being used in a larger project, that each team member switches frequently between teams, building all-important calibration, and camaraderie among the whole group.

<u>Suggestions for Laying out Plots</u>: If you are laying out a circular plot, work with two or more people. One person stands at the center of the plot and holds the tape case while the other walks the end of the tape out to the appointed distance (radium 5.6 for 100 m^2 circle, radius 11.3 m for a 400 m^2 circle, and radius 17.6 m for a 1000m^2 circle). The walker then fixes the tape end with a pin flag and walks back to the center where he/she instructs the center person to walk in the opposite direction of the already laid out tape radius, stretching the rest of the tape to an equal

length (another 11.3 or 17.6 m) to the opposite edge of the plot, where he/she affixes it with another pin flag.   This process is again repeated with another tape laid out perpendicular to the first so that an "✛ " shape is created .   The margins of the circle can be further delineated by measuring to the center of the circle with an optical tape measure (rangefinder) and marking mid points between the four ends of the crossed tapes.

When laying out square or rectangular plots work with two or more people per team. If doing a rectangle, determine the long axis of the plot first and have one person be stationed at the zero m end of the tape while the other person walks the unrolling tape case out to the appropriate length. The stationary end person can guide the walker, keeping them moving in a straight line. Once that tape is laid out and the far end staked, the team lays out another tape perpendicular to the first, either at one end, using the same type of process. This establishes the width of the rectangle (or square). Using an optical rangefinder and pin-flags, or colored flagging the team can further mark additional points along the other parallel long axis and short axis of the plot (every 5 m for shorter plots or every 10 m for longer plots is suggested) so that the entire plot boundary can be easily visualized.

References:

Barbour M.G., J.H. Burk, and W.D. Pitts 1987. Terrestrial Plant Ecology, Second Edition. Benjamin/Cummings Publishing Co. Menlo Park, CA. 634 pages.

Sawyer and Keeler-Wolf. 1995. Manual of California Vegetation. California Native Plant Society, Sacramento, CA. 471 pages

The Nature Conservancy and Environmental Systems Research Institute. 1994. Final Draft, Standardized National Vegetation Classification System. Prepared for United States Department of the Interior, National Biological Survey, and National Park Service. Arlington, VA. Complete document available at the following website: http‖:biology.usgs.gov/npsveg/fieldmethods.html

Suggested Equipment:
Equipment List: Prices as of May 2000, toll free orders from Forestry Suppliers (1-800-647-5368) (item numbers in parentheses)

Chaining pins, surveyor steel (#39167)	$21.50
Fiberglass tapes 2 - 165'/50 m (#39972)	$42.90
Logbook cover 8 ½ " x 12" (#53200)	$23.95
Perforated flagging (#57960)	$1.95
UTM Coordinate Grid (#45019)	$16.95
Rangefinder, 10-75m (#38973)	$51.60
Silva Compass w/ clinometer (#37036)	$43.90
Garmin GPS 12XL (#39095, #39111)	$244.90

CALIFORNIA NATIVE PLANT SOCIETY RELEVÉ FIELD FORM CODE LIST (revised 3/0107)

MACRO TOPOGRAPHY
00 Bench
01 Ridge top (interfluve)
02 Upper 1/3 of slope
03 Middle 1/3 of slope
04 Lower 1/3 of slope (lowslope)
05 Toeslope (alluvial fan/bajada)
06 Bottom/plain
07 Basin/wetland
08 Draw
09 Other
10 Terrace (former shoreline or floodplain)
11 Entire slope
12 Wash (channel bed)
13 Badland (complex of draws & interfluves)
14 Mesa/plateau
15 Dune/sandfield
16 Pediment
17 Backslope (cliff)

MICRO TOPOGRAPHY
01 Convex or rounded
02 Linear or even
03 Concave or depression
04 Undulating pattern
05 Hummock or Swale pattern
06 Mounded
07 Other

SITE IMPACTS
01 Development
02 ORV activity
03 Agriculture
04 Grazing
05 Competition from exotics
06 Logging
07 Insufficient population/stand size
08 Altered flood/tidal regime
09 Mining
10 Hybridization
11 Groundwater pumping
12 Dam/inundation
13 Other
14 Surface water diversion
15 Road/trail construction/maint.
16 Biocides
17 Pollution
18 Unknown
19 Vandalism/dumping/litter
20 Foot traffic/trampling
21 Improper burning regime
22 Over collecting/poaching
23 Erosion/runoff
24 Altered thermal regime
25 Landfill
26 Degrading water quality
27 Wood cutting
28 Military operations
29 Recreational use (non ORV)
30 Nest parasitism
31 Non-native predators
32 Rip-rap, bank protection
33 Channelization (human caused)
34 Feral pigs
35 Burros
36 Rills
37 Phytogenic mounding
38 Sudden oak death syndrome (SODS)

PARENT MATERIAL
IGTU	Igneous (type unknown)
VOLC	General volcanic extrusives
RHYO	Rhyolite
ANDE	Andesite
BASA	Basalt
ASHT	Ash (of any origin)
OBSI	Obsidian
PUMI	Pumice
PYFL	Pyroclastic flow
VOFL	Volcanic flow
VOMU	Volcanic mud
INTR	General igneous intrusives
GRAN	Granitic (generic)
MONZ	Monzonite
QUDI	Quartz diorite
DIOR	Diorite
GABB	Gabbro
DIAB	Diabase
PERI	Peridotite
METU	Metamorphic (type unknown)
GNBG	Gneiss/biotite gneiss
SERP	Serpentine
SCHI	Schist
SESC	Semi-schist
PHYL	Phyllite
SLAT	Slate
HORN	Hornfels
BLUE	Blue schist
MARB	Marble
SETU	Sedimentary (type unknown)
BREC	Breccia (non-volcanic)
CONG	Conglomerate
FANG	Fanglomerate
SAND	Sandstone
SHAL	Shale
SILT	Siltstone
CACO	Calcareous conglomerate
CASA	Calcareous sandstone
CASH	Calcareous shale
CASI	Calcareous siltstone
DOLO	Dolomite
LIME	Limestone
CALU	Calcareous (origin unknown)
CHER	Chert
FRME	Franciscan melange
GREE	Greenstone
ULTU	Ultramafic (type unknown)
MIIG	Mixed igneous
MIME	Mixed metamorphic
MISE	Mixed sedimentary
MIRT	Mix of two or more rock types
GLTI	Glacial till, mixed origin, moraine
LALA	Large landslide (unconsolidated)
DUNE	Sand dunes
LOSS	Loess
CLAL	Clayey alluvium
GRAL	Gravelly alluvium
MIAL	Mixed alluvium
SAAL	Sandy alluvium (most alluvial fans and washes)
SIAL	Silty alluvium
OTHE	Other than on list

SOIL TEXTURE
COSA	Coarse sand
MESN	Medium sand
FISN	Fine sand
COLS	Coarse, loamy sand
MELS	Medium to very fine, loamy sand
MCSL	Moderately coarse, sandy loam
MESA	Medium to very fine, sandy loam
MELO	Medium loam
MESL	Medium silt loam
MESI	Medium silt
MFCL	Moderately fine clay loam
MFSA	Moderately fine sandy clay loam
MFSL	Moderately fine silty clay loam
FISA	Fine sandy clay
FISC	Fine silty clay
FICL	Fine clay
SAND	Sand (class unknown)
LOAM	Loam (class unknown)
CLAY	Clay (class unknown)
UNKN	Unknown
PEAT	Peat
MUCK	Muck

DOMINANT VEGETATION GROUP
Trees:
TBSE	Temperate broad-leaved seasonal evergreen forest
TNLE	Temperate or subpolar needle-leafed evergreen forest
CDF	Cold-deciduous forest
MNDF	Mixed needle-leafed evergreen-cold deciduous. forest
TBEW	Temperate broad-leaved evergreen woodland
TNEW	Temperate or subpolar needle-leaved evergreen woodland
EXEW	Extremely xeromorphic evergreen woodland
CDW	Cold-deciduous woodland
EXDW	Extremely xeromorphic deciduous woodland
MBED	Mixed broad-leaved evergreen-cold deciduous woodland
MNDW	Mixed needle-leafed evergreen-cold deciduous woodland

Shrubs:
TBES	Temperate broad-leaved evergreen shrubland
NLES	Needle-leafed evergreen shrubland
MIES	Microphyllus evergreen shrubland
EXDS	Extremely xeromorphic deciduous shrubland
CDS	Cold-deciduous shrubland
MEDS	Mixed evergreen-deciduous shrubland
XMED	Extremely xeromorphic mixed evergreen-deciduous shrubland

Dwarf Shrubland:
NMED	Needle-leafed or microphyllous evergreen dwarf shrubland
XEDS	Extremely xeromorphic evergreen dwarf shrubland
DDDS	Drought-deciduous dwarf shrubland
MEDD	Mixed evergreen cold-deciduous dwarf shrubland

Herbaceous:
TSPG	Temperate or subpolar grassland
TGST	Temperate or subpolar grassland with sparse tree
TGSS	Temperate or subpolar grassland with sparse shrublayer
TGSD	Temperate or subpolar grassland with sparse dwarf shrub layer
TFV	Temperate or subpolar forb vegetation
THRV	Temperate or subpolar hydromorphic rooted vegetation
TAGF	Temperate or subpolar annual grassland or forb vegetation

Sparse Vegetation:
SVSD	Sparsely vegetated sand dunes
SVCS	Sparsely vegetated consolidated substrates

Simplified Key to Soil Texture
(Adapted from Brewer and McCann 1982)

Place about three teaspoons of soil in the palm of your hand. Take out any particles ≥ 3 mm in size.

A. Does soil remain in ball when squeezed in your hand palm?

     Yes, soil does remain in a ball when squeezed.............….. **B**

     No, soil does not remain in a ball when squeezed….. **sand**

                                                           SAND Sand (class unknown)
Very coarse texture.……………………….…………COSA Coarse sand
Moderately coarse texture…………………….……… MESN Medium sand
Moderately fine texture.…………………….…………. FISN Fine sand

B. Add a small amount of water until the soil feels like putty. Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger. Does soil make a ribbon?

     Yes, soil makes a ribbon; though it may be very short...**C**

     No, soil does not make a ribbon...**loamy sand**
Very gritty with coarse particles…..COLS Coarse, loamy sand
Moderately to slightly gritty with medium to fine particles.........MELS Medium to very fine, loamy sand

C. Does ribbon extends more than one inch?

     Yes, soil extends > 1 inch...**D**

     No, soil does not extend > 1 inch..Add excess water

        Soil feels gritty………………….……………….……………….…..…...............**loam or sandy loam**
                                             LOAM Loam (class unknown)
Very gritty with coarse particles…..MCSL Moderately coarse, sandy loam
Moderately gritty with medium to fine particles.......................MESA Medium to very fine, sandy loam
Slightly gritty ....MELO Medium loam

        Soil feels smooth..**silt loam**
                                            MESIL medium silt loam

D. Does soil extend more than 2 inches?

     Yes, ribbon extends more than 2 inches, and does not crack if bent into a ring..........................**E**

     No, soil breaks when 1–2 inches long; cracks if bent into a ring…………………...Add excess water

        Soil feels gritty…..**sandy clay loam or clay loam**
Very gritty…...………………...…………………………...MFSA Moderately fine sandy clay loam
Slightly gritty…………………………...………………….MFCL Moderately fine clay loam

        Soil feels smooth...……..............**silty clay loam or silt**
Moderately fine texture……………………………………MFSL Moderately fine silty clay loam
Very fine texture……………………………………….. MESI Medium silt

E. Soil makes a ribbon 2+ inches long; does not crack when bent into a ring................Add excess water

        Soil feels gritty...**sandy clay or clay**
                                         CLAY Clay (class unknown)
Very gritty…...……………………………………… FISA Fine sandy clay
Slightly gritty…………………………………….….. FICL Fine clay

        Soil feels smooth..…….…....**silty clay**
                                           FISC Fine silty clay

_____

UNKN = UNKNOWN   PEAT = PEAT   MUCK = MUCK

Artificial Key to the Systems and Classes

Key to the Systems

1. Water regime influenced by oceanic tides, and salinity due to ocean-derived salts 0.5% or greater.
   2. Semi-enclosed by land, but with open, partly obstructed or sporadic access to the ocean. Halinity wide-ranging because of evaporation or mixing of seawater with runoff from land . . . . ESTUARINE
   2'. Little or no obstruction to open ocean present. Halinity usually euhaline; little mixing of water with runoff from land 3
      3. Emergents, trees, or shrubs present . . . . ESTUARINE
      3'. Emergents, trees, or shrubs absent. . . . . MARINE
1'. Water regime not influenced by ocean tides, or if influenced by oceanic tides, salinity less than 0.5%
   4. Persistent emergents, trees, shrubs, or emergent mosses cover 30% or more of the area . . . . . .PALUSTRINE
   4'. Persistent emergents, trees, shrubs, or emergent mosses cover less than 30% of substrate but nonpersistent emergents may be widespread during some seasons of year 5
      5. Situated in a channel; water, when present, usually flowing . . . . RIVERINE
      5'. Situated in a basin, catchment, or on level or sloping ground; water usually not flowing. 6
         6. Area 8 ha (20 acres) or greater . . . . .LACUSTRINE
         6'. Area less than 8 ha 7
            7. Wave-formed or bedrock shoreline feature present or water depth 2 m (6.6 feet) or more . . . .
            . . . . LACUSTRINE
            7'. No wave-formed or bedrock shoreline feature present and water > 2 m deep . . . . . . PALUSTRINE

Key to the Classes

1. During the growing season of most years, aerial cover by vegetation is less than 30%.
   2. Substrate a ridge or mound formed by colonization of sedentary invertebrates (corals, oysters, tube worms) . . .
   . . . . REEF
   2'. Substrate of rock or various-sized sediments often occupied by invertebrates but not formed by colonization of sedentary invertebrates 3
      3. Water regime subtidal, permanently flooded, intermittently exposed, or semipermanently flooded. Substrate usually not soil 4
         4. Substrate of bedrock, boulders, or stones occurring singly or in combination covers 75% or more of the area . . . . ROCK BOTTOM
         4'. Substrate of organic material, mud, sand, gravel, or cobbles with less than 75% areal cover of stones, boulders, or bedrock. . . . . UNCONSOLIDATED BOTTOM
      3'. Water regime irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded. Substrate often a soil 5
         5. Contained within a channel that does not have permanent flowing water (i.e., Intermittent Subsystem of Riverine System or Intertidal Subsystem of Estuarine System) . . . . STREAMBED
         5'. Contained in a channel with perennial water or not contained in a channel 6
            6. Substrate of bedrock, boulders, or stones occurring singly or in combination covers 75% or more of the area . . . . .ROCKY SHORE
            6'. Substrate of organic material, mud, sand, gravel, or cobbles; with less than 75% of the cover consisting of stones, boulders, or bedrock. . . . . UNCONSOLIDATED SHORE
1'. During the growing season of most years, percentage of area covered by vegetation 30% or greater.
   7. Vegetation composed of pioneering annuals or seedling perennials, often not hydrophytes, occurring only at time of substrate exposure 8
      8. Contained within a channel that does not have permanent flowing water. . . . . STREAMBED (VEGETATED)
      8'. Contained within a channel with permanent water, or not contained in a channel
      . . . . UNCONSOLIDATED SHORE (VEGETATED)
   7'. Vegetation composed of algae, bryophytes, lichens, or vascular plants that are usually hydrophytic perennials .
  9
      9. Vegetation composed predominantly of nonvascular species 10
         10. Vegetation macrophytic algae, mosses, or lichens growing in water or the splash zone of shores . . . . .
         . . . . AQUATIC BED
         10'. Vegetation mosses or lichens usually growing on organic soils and always outside the splash zone of shores . . . . .MOSS-LICHEN WETLAND
      9'. Vegetation composed predominantly of vascular species 11
         11. Vegetation herbaceous 12
            12. Vegetation emergents. . . . . .EMERGENT WETLAND
            12'. Vegetation submergent, floating-leaved, or floating. . . . . .AQUATIC BED
         11'. Vegetation trees or shrubs 13
            13. Dominants less than 6 m (20 feet) tall . . . . .SCRUB-SHRUB WETLAND
            13'. Dominants 6 m tall or taller . . . . .FORESTED WETLAND